Economic Values of Protected Areas Associated with Private Property Along Michigan's Lake Superior Shoreline

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Abstract

Increasing shoreline development along the Great Lakes has caused public concern regarding the loss of associated ecological attributes. In more remote areas, such as Lake Superior's shoreline, informal public access to shoreline across private property is becoming less common as lakeshore properties are subdivided and developed. Shoreline development increases property values and are an important source of tax revenue for local governments. Using hedonic analysis we examined 162 non-shoreline properties within three miles of Michigan's Lake Superior shoreline to determine if proximity to public access to the Lake increased property value. Distance to public access to Lake Superior was a statistically significant variable in explaining land value per acre, as were variables for parcel size, county, stumpage value, view, road access, and distance to towns. We also examined 53 shoreline parcels. For shoreline parcels parcel size, lakefront length, beach type, county, and distance to a small town were statistically significant. Distance to public access to Lake Superior was not statistically significant for shoreline properties.

Key words: hedonic analysis, property values, Lake Superior, parks, open space, rural development.

I. Introduction

Rural counties in Michigan are experiencing growth, much of it driven by regional natural amenities. The shorelines of the Great Lakes, including Michigan's Lake Superior shoreline, is under increasing ecological pressure from property division (Orr, 1997) and development. The shoreline development can lead to environmental degradation (Bredin and Bankard, 2000) and conflict among residents, some of whom prefer economic development with little regulation and others who prefer stricter land use controls. These conflicts may be exacerbated by other divisions between seasonal and permanent residents (Green *et al*., 1996). Urban studies (Barnett, 1985; Do and Grudnitski, 1991; Doss and Taff, 1996; Hammer *et al*., 1974; Lee and Linneman, 1998; Vaughn, 1981) have shown that proximity to parks can raise property values. Does a similar relationship hold for parks along Michigan's Lake Superior shoreline? Do parks with access to Lake Superior contribute to increased property values of non-shoreline property?

Figure 1. Sign beside US Highway 41 in Baraga County, Michigan.

In order to answer this question we developed a hedonic model (Freeman, 1979; Scotchmer 1984) of property values where one of the attribute values was proximity to the park. We collected primary data on attributes of the property and analyzed the results. Hedonic analysis uses a general linear model to estimate parameters associated with independent variables, the property attributes, with some measure of property value as the independent variable. If parks play a role in determining the value of a property the estimated parameter for the distance from the property to the park should be significant and negative. That is, property values should increase as distance to the park decreases. In addition, in order to compare properties near Lake Superior with those adjacent to Lake Superior we estimated a separate equation for properties located directly adjacent to Lake Superior.

II. Background.

In this section we briefly describe the ecological values of large lake shoreline. For many it is the preservation of this unique environmental setting which justifies the preservation and public protection of lakeshore. We also briefly describe, the opposite side of the question, the desire to develop lakeshore, particularly to increase the tax base and the economic base of a small jurisdiction, frequently counties, towns, small cities surrounded by extensive rural areas, and townships. We then review previous literature which has hedonic pricing to determine the value of resource-based amenities. Much of the development of our model came from the work others have done. It is important to note that much of the similar work has been done in urban and suburban areas, in contrast to the rural and remote setting of Michigan's Lake Superior shoreline.

Ecological Values

Within the literature, the idea of managing a Great Lakes shoreline for ecological values is a relatively recent idea. Earlier literature often focuses on management for development purposes. Even through the 1980s documents such as *Great Lakes Shoreline Resource Management: A Selected Annotated Bibliography* (Knight *et al*., 1987) is dominated by literature focusing on lake level changes and structures and other management activities to mitigate erosion and other problems of shoreline landowners.

On a broad scale there is more recent concern about the development of rural areas and the fragmentation of landscapes which may result from such development (Gobster *et al*., 2000). The State of Wisconsin Northern Initiatives Report (Wisconsin Department of Natural Resources, 1995) concluded that the rapid development of Wisconsin's inland lakes was effecting both ecological integrity and the aesthetic values associated with the lakes. Great Lakes shorelines have also seen decline in environmental quality with lakeshore development.

Further complicating our understanding of shoreline ecological processes is our understanding of scale and the impact of development. For example, Moore and Keddy (1989) found that patterns of species richness vary with the size and coarseness of scale of study. Tilman (1985), studying a wide range of plant communities, concluded plant succession is related to underlying resources available within the community and level and timing of disturbance.

Rare species such as the piping plover and Pitcher's Thistle are threatened by shoreline development (Bredin and Bankard, 2000). Shoreline red oak habitat, a relatively rare forest type along Lake Superior's shore, is more likely to be developed than most other forest cover types (Orr, 1997). The Superior Work Group (2000) of the Lake Superior Binational Program has enumerated a range of habitats which are unique to shorelines and are important habitat for vegetation and wildlife in the region. Shoreline is also critical for migrating shorebirds. Their report identifies the concentration of human use along lakeshores as an area for mitigation.

Great Lakes' wetlands perform critical biological functions along the shorelines. Except during a small period during spring melt and runoff, wetlands act as key agents in controlling the flow of nutrients and dissolved organic matter in to the Great Lakes (Wetzel, 1992). The impact from wetland disturbance can be long lasting. Even after mitigation techniques are employed, marshes and other aquatic communities which depend upon seedbanks may not regenerate. Disturbance and development may have destroyed the seed source necessary for revegetation to occur (Westcott *et al*., 1997). While the ecological attributes of wetlands are widely reported it is important to note there is substantial variability in types of shoreline wetlands and that, counterintuitively, it may be the infertile wetlands which hold more endemics and rare communities (Moore *et al*., 1989). Many lakeshore wetlands along Lake Superior have low standing biomass due to natural wave and ice scour or soils with low nutrient availability. The wide range of wetland types and their biological value makes them key components in shoreline preservation strategies.

Shoreline development also has an impact on the offshore biological communities. Human population increases and the associated shoreline development leads to changes in offshore habitat, offshore vegetation habitat, young fish populations, and eventually a decline in the fishery (Leslie and Timmins, 1994). Brazner and Beals (1997) also found that shoreline disturbance and development in both wetland and beach habitats changed the offshore fish assemblages.

Many sites which are developed include structures or landscaping designed to reduce the impact of variability, including changes in lake level, upon the property. *Stophostyles helvola* is one species which requires such variability and microsite differences for regeneration and survival (Yanful and Maun, 1996). Seed banks in general benefit from and are a response to ecological variability.

The US Fish and Wildlife Service has examined the biological impact of shoreline protection and construction, activities frequently associated with shoreline development. Two common protection methods in the Great Lakes region have been bulkheads and associated dredging and groins. Typically littoral zone production is reduced and foreshore habitat is eliminated or dramatically reduced. Turbidity may increase, particularly when dredging is associated with the construction. While today there are fewer instances of construction of bulkheads and groins, particularly by private landholders, they are still in use in the Great Lakes region (Mulvihill *et al*., 1980).

Dunes are especially sensitive to human impact and development. Even relatively limited use can degrade a dune system (Bowles and Maun, 1982; Bonanno *et al*., 1998). These shoreline plant communities can follow narrow gradation patterns based on competitive performance (Gaudet and Keddy, 1995). Development can disrupt these patterns, breaking the continuum of plant species and communities.

Shorelines include a wide range of important ecological systems. While the focus has often be on wetlands, other functional ecological types provide a for the range and balance of processes that are linked to both offshore and inland ecosystems. Development can reduce the functional abilities of the shoreline.

Economic Development.

Stynes *et al*. (1997) investigate the increase in seasonal homes in the northern lower peninsula of Michigan. They found that much of the development of seasonal homes was associated with access to water, both inland waters and the Great Lakes. Their study highlighted the many economic benefits associated with the addition of new seasonal homes to a regional economy. Hunt *et al*. (no date) also find that seasonal homes contribute to and shift a local economy. Hunt *et al*. found that retirees were interested in access to water, either directly or through public access and viewsheds. The Upper Peninsula of Michigan receives substantial economic benefits from income typically associated with retirees who are moving to the area, either permanently or seasonally, for the amenity values. Kendall and Pigozzi (1994) found that for all shoreline counties in this study area except Marquette County, 40% or more of all 1986 personal income was nonemployment income, including social security and pension payments and dividend and interest earnings. Given the increasing numbers of second homes in the region, one could surmise these figures are larger today. The development of seasonal and second home markets has become an important driver in recreational communities, at times outweighing the importance of short-stay vacationers which is more typically viewed as the “recreation and tourism” portion of the economy (Beale and Johnson, 1998; Stynes, Zheng and Stewart, 1997).

Slaats and Kreutzwiser (1993) reviewed the impact of shoreline development regulation in Ontario along the lower Great Lakes. Typical regulatory frameworks, including Ontario’s shoreline development regulation by Conservation Authorities, require enforcement of rules which are disliked by at least a significant portion of the population. Regulation then becomes costly. Slaats and Kreutzwiser determined regulation was uneven in both implementation and enforcement.

The State of Wisconsin Northern Initiatives Report (Wisconsin Department of Natural Resources, 1995) summarized an extensive survey to determine changes in lake development in northern Wisconsin. Lakeshore housing doubled since the 1960s. Two-thirds of those lakes previously untouched had at least one new house built on the shoreline. Prices of lakeshore property had increased dramatically.

Kilman and Rose (1996) report that from 1990 to 1995 the two dominant activities driving population growth in rural counties were retirement, 13.8% of all growth, and recreational activities, 9.7%. Commuting (6.9%), manufacturing (4.6%), and farming (3.2%) were less important. The retirement and recreational growth is tied to a preference by people for lower density residences which are more typically acted upon when economic conditions are good, both for the individual and the nation as a whole (Brown *et al.*, 1997). Retirement often allows indiviudals to act upon these previously latent preferences. Such development has already had an impact on the development of shoreline. Derus (1996) reported how recreational purchases for vacation homes had driven up vacation home prices in Wisconsin. Dietz (1996) describes the conflict that can arise when private property once open to the public, though private they are effectively a common resource, becomes subdivided and the public is then excluded. From a comprehensive perspective, shoreline development appears as an economic good which must be balanced against the desire for public access and ecological protection.

Previous Research in Hedonic Pricing of Natural Resource Amenities.

Hedonic models estimate the price or value of a good or service by aggregating the values of attributes associated with the good or service. Usually the model is a linear model of the form

$$y_i = \alpha + \boldsymbol{\beta}\mathbf{X_i} + \mu_{i.}$$

y_i is the value or value per unit of the i^{th} good or service in question. In our case this is the transformed price (per acre) of the property. α is estimated intercept of the model. $\boldsymbol{\beta}$ is a vector of estimated parameters or the independent variables. $\mathbf{X_i}$ is a vector of the observed values for the i^{th} property of the attributes that determine the price of a good. μ_i is the error or random term for the i^{th} property.

Urban and regional economists often use such models for two practical purposes. The primary focus of a hedonic model may be to determine a predictive model, where given a set of $\mathbf{X_i}$ the researcher can predict y_i. Alternatively, the primary focus may be to estimate a value β_j for some independent variable in the $\mathbf{X_i}$ matrix. We use the model in this second manner. In our model the $\mathbf{X_i}$ matrix includes timber value, building vs. land value, utilities and utility access, road access, and, of greatest interest in this study, proximity to public land with access to Lake Superior. We estimate the β vector, focusing on the value associated with proximity to a park on the shore of Lake Superior. When determining the importance of a selected independent variable the other variables must be included in the model to control for the impact of other attributes and, statistically, to eliminate bias in the estimation (Leamer, 1983).

While the earliest models were ordinary least squares estimates with strictly linear functional forms and without transformed variables, economists have since applied more sophisticated models to extract information. For example, Arguea and Hsiao (1993), while focusing on hedonic price estimations in the automobile industry, cover problems associated with the selection of attribute variables and the functional form including transformations of the linear model. Many studies include transformation of variables to improve model specification. Logarithmic transformations are the most common (Hushak and Sadr, 1974; Huh and Kwak, 1997). More germane to this study, Scotchmer (1984), Goodman (1978) and Wallace (1996) provide the theoretical framework of hedonic pricing and Scotchmer in particular focuses on how hedonic pricing may be used to evaluate the value of public amenities.

Our underlying hypothesis, that preserving amenity values of nearby natural amenities can increase the value of other property, was also hypothesized for coastal protection in California by the California Coastal Commission (Frech and Lafferty, 1984). Frech and Lafferty assumed distance from the open space which resulted from Commission mandates would decrease the impact of the open space on housing prices. Since the Commission could regulate land use anywhere along the coast Frech and Lafferty used dummy variables for land zones from the coast. In our study we used distance from the park rather than zones. They used economic conditions in a quarter rather than dummy variables to reflect changes over time. Our study area was much broader geographically and local economic conditions could vary from county to country. For example, Ontonagon County was still feeling the economic impact of a company closing. The closure had little impact in most other counties. We used a dummy variable for each year of sale and a dummy variable for each county. Frech and Lafferty also controlled for property attributes. They found that those houses closest to the coast did have increased value due to an amenity effect while all houses within 13 miles of the coast had a price increase due to a scarcity effect.

Brown and Pollakowski (1977) estimated the value of proximity to urban lakes in Seattle. They found that total property value increase for houses within 4,000 feet of Green Lake due to the open, public-access space around Green Lake was $13,000,000 (indexed as 1967 dollars). They used hedonic pricing to estimate these values and controlled for attributes of the sample properties.

Kirshner and Moore (1989) studied property values in the San Francisco Bay area, focusing on water quality. In addition to water quality, they also used distance to water and view among the property attributes in their hedonic analysis. Proximity to water, better water quality and better views were significant independent variables which explained property prices. Barnett (1985) conducted a study of the residential market in Perth. His study, while in an urban area, included environmental factors similar to those in this study. He found that land prices were significantly increased by proximity to public open spaces and the coast, as we hypothesize in this study. Because of the large size of the residential market and the compactness of area studied he obtained a good statistical fit, $R^2 = 0.66$ for his linear model and $R^2 = 0.76$ for the logarithmic model. Hammer *et al*. (1974) also reported that proximity to large urban parks and open spaces increased residential property values. Doss and Taff (1996) use hedonic analysis to value the proximity of property to different types of wetlands. While observing the value of a natural amenity their study focused on urban properties in Ramsey County, Minnesota. They found that proximity to all types of wetlands except forested wetlands increased property values. Their control variables were typical of many urban studies - proximity to schools, lots size, living area, bathrooms, and age of house. Proximity to Lake Michigan increased land values in Chicago (Yeates, 1965). Seoul's greenbelt significantly increased property values (Lee and Linneman, 1998).

Leefers and Jones (1996) used a hedonic model to determine the value of Natural Rivers designation in market price of river front property. The price of the parcel was the dependent variable and the key independent variable was whether or not the property was on a Natural River. Other independent variables captured other implicit values in the property price. Similar to our study Leefers and Jones used real property transfers rather than assessed value as the dependent variable.

Egan and Luloff (2000) review the social impact of the growth of homes in rural forested areas. How new landowners, and even new agencies and institutions, which utilize recreation and amenity values are incorporated in to decision making has become a political question of both practical and theoretical concern in areas with changing demographics (Reed and McGill, 1997; Rubio and Goetz, 1998).

Rural settings, especially those near cities, are preferred residential sites (Fuguitt and Brown, 1990; Shonkwiler and Reynolds, 1986; Song, 1996). We include distance to two levels of city or town size as independent variables in our model. Land value has also been related to parcel size (Thorsnes and McMillen, 1998). Smaller sizes frequently trade at a premium. Turner *et al*. (1996) found that, though drivers and rates of change may vary by region, that across regions private ownership and public ownership have different landscape cover patterns. Private ownership typically has greater land cover fragmentation. While our study is not intended to observe these types of differences and our results indicate that preserving public land along lakeshores helps raise nearby property values. Increased public land, especially larger public parcels, would reduce cover fragmentation.

Schutjer and Hallberg (1968) conducted one of the few rural studies of amenity values. They found that water recreational development for public access increased the value of nearby rural property. They did not use hedonic analysis but were able to conduct a before-and-after study when recreational lake access was developed in Pennsylvania. As we control for timber value, an alternative land use, Schutjer and Hallberg controlled for agricultural land use value using dummy variables for agricultural land use classes.

Most hedonic studies have focused on urban or suburban property values in developed countries. Geoghegan *et al*. (1997) studied 1990 property transactions within 30 miles of Washington D.C. These types of studies use urban characteristics such as racial demographics, age of house, access (often the distance to a major highway), political subdivisions such as towns and counties, and income data. The population and building density in such areas makes it easier to use census tract data and to collect relatively large samples in a small area. Pogodzinski and Sass (1991) were able to collect 1,711 single-family home transactions in one month in Santa Clara County, California. Our study attempts to limit the time frame, however, in order to develop a robust sample our data includes transactions over a three year time period. We control for changes over time with dummy variables. Other examples of these urban and suburban studies include Clapp and Giaccotto (1998), Doss and Taff (1996), Correll *et al*. (1978) who focus on the implicit value of greenbelts in urban residential property values, Do and Grudnitski (1991) who find that the amenity value of proximity to golf courses is positive, Freeman (1979), and Giannias (1996) who estimated the price impact of air quality. Englin (1996) used hedonic pricing to estimate the amenity value of rainfall; residential property owners prefer less rainfall but holding rainfall constant prefer seasonal variation in rainfall. Dorfman *et al*. (1996) who studied the implicit value of protecting houses from shoreline erosion along the Great Lakes.

While we use hedonic pricing to estimate the value of a positive property attribute, hedonic pricing has also been used to estimate to extract the negative impact of proximity to airports and the associated noise pollution (Nelson, 1980) and air pollution (Anderson and Crocker, 1971; Harrison and Rubinfeld, 1978).

III. Methods and Data Collection

A hedonic pricing model assumes that the value for a particular item in a large market, where the individual items are substantially different, is composed of set of underlying prices for attributes of the commodity. In this case the price of property on or near the Lake Superior shoreline would be composed of the value of underlying attributes such as size of property, buildings, timber value, access, and proximity to public access to Lake Superior. We estimate the model to determine the value of proximity of public access, not to develop a real estate valuation model for property. Interpretation and use of both the methods and the results should consider the research objective.

Study Area

This study covers the nine Michigan counties which have shoreline along Lake Superior: Alger, Baraga, Chippewa, Gogebic, Houghton, Keweenaw, Luce, Marquette, and Ontonagon Counties. We used only private properties within three miles of Lake Superior which were not located in a legally incorporated city. While the focus was on non-shoreline property, we included both shoreline and non-shoreline properties in our sample.

Model Description and Variables

Following the standard hedonic price model format we hypothesized the following linear equation:

$$P_t = F(X_1, X_2, \ldots, X_n)$$

where,

P_t = price in year t

and

X_i are n independent variables (i = 1, …, n) which describe the attributes of the properties. n = 162 for non-shoreline property, n = 53 for shoreline property.

In order to determine which attributes were important we reviewed the literature on hedonic estimation of land values and also talked with local assessors, appraisers, and real estate agents.

We derived the following initial list of variables:

Dependent Variable.

Our dependent variable was the natural log of land price per acre based upon transaction evidence. We used transaction evidence rather than assessed value since many sale record indicated that properties held for more than ten years were under-assessed. Transaction evidence was the most reliable method of determining value or willingness to pay for a property. Unfortunately transaction evidence does not separate building price from land price while assessors records do make such a distinction. We multiplied the transaction value of the land by a ratio of assessed land value to assessed total value to estimate the transaction value of the land. A dummy variable for presence of a building was included in the dummy variables. If the assessors land value to building value ratios were accurate the value for the building dummy variable should not be statistically significant different from zero. Many studies use total price of the land or total price per acre or the natural log of those values. These studies are typically in urban areas and all properties have buildings. Lot size may be fairly uniform in an urban study. Since our parcels were from less than one acre to 80 acres in size we used the natural log of land price per acre.

Independent Variables.

Based upon our review of the literature and discussions with local experts in property valuation we initially selected the independent variables shown in Table 1. The variables were determined through a review of the previous literature and by discussing property transactions with real estate agents, appraisers and township tax assessors.

Many of these variables are also used in other studies. Radeloff *et al*. (2001) report that development in the Wisconsin Pine Barrens is dramatically different on public vs. private land. The area has seen increasing development in the last 25 years and public lands have protected the portions of the landscape. Rivers, streams, and lakes have been a focus of development. We include a dummy variable for these attributes in our model.

Table 1: Initial set of Independent Variables and Measures

Independent Variable	Measure
Year of sale	
Frontage	feet
Sandy beach	%
Rocky	%
Bluff	%
Vegetation	%
Property size	acres
Property structures	
Stumpage value	dollars
Value of buildings	dollars
Recent subdivision of property	yes=1, no=0
Stream	yes=1, no=0
Other lake	yes=1, no=0
View	
Lake	yes=1, no=0
Mountain	yes=1, no=0
Road access	yes=1, no=0
Paved	yes=1, no=0
Gravel	yes=1, no=0
Seasonal	yes=0, no=1
Utility access	
Water	yes=1, no=0
Sewer	yes=1, no=0
Electricity	yes=1, no=0
Natural gas	yes=1, no=0
Distance to nearest park entrance	miles
Park size	acres
Special water access	
Boat launch	yes=1, no=0
Public beach	yes=1, no=0
Distance to city (name)	miles
Employment	Census Bureau Job Reports
Urban amenities	notation
Restrictions	
Taxes	dollars, notation
Easements	yes=1, no=0 (Describe)
Zoning	notation
Statutory wetland	yes=1, no=0

In addition to expert advice on variables, there is anecdotal evidence that each of these variables has an influence on the value of the properties. The following property advertisements are from the Summer 2000, Fall 2000, and Winter 2001 Keweenaw Peninsula Multiple Listing Service Property Brochures and various issues of local papers.

> "Nice 80 care recreational/investment parcel south of Ontonagon. This parcel is bordered by State land w/good access." The advertisement emphasizes proximity of state land and accessibility.

> "80 acres off of Green Acres Rd. in Portage. Nice property located just outside of Houghton with good access." Proximity to town and accessibility are listed as attractive features of the property.

> "560 acres on Lac La Belle Rd in Sherman Township!!! Excellent parcel for investment or recreation! Developed logging roads through parcel and has been select cut." Timber value is emphasized for this property.

> "Very cute 2 BR cottage on Lake Superior. 60' of bluff frontage." The type of lake access is important.

> " 'Hunter's paradise' Build that cabin and enjoy hunting deer and small game on 80 acres w/fir and maple trees, a natural spring and 2 track road that runs ½ mile depth of this property. Surrounded by 1000s of acres of CRF land." Adjoining commercial forest land with restrictions and legal public access are advertised as benefit associated with this property.

> "Newly Listed! 3 BR cottage is in the heart of 4 seasons vacation land. Close to state and CFA land, and public access of Silver River, Huron Bay, and 2nd Sand Beach." Water access and access to public land and private land open to the public are accessible.

> "Waterfront home! 2 BR updated home with village utilities. Has 150' of Lake Superior Frontage. Beautiful view of Huron Mts, close to Baraga Marina." The property has lakefront but cannot be used of boat access so proximity to Lake access is listed as a benefit. The view and utilities are other amenities.

> "U.P. Getaway! Hunters and fisherman can hang their hats in this 1 BR home with sauna and cozy cabin. Close to marina, beaches, hunting, hiking, and fishing." Lake access is a listed attribute of this property.

> "Great recreational parcel!!! 79+ acres on Bootjack Rd in Torch Lake. This parcel is nicely wooded and butts up to state land for nice access to the canal. Excellent hunting also!." Indirect access to water (the Canal provides direct and easy access to Lake Superior) through public land is listed as a positive feature of this property.

> "House of the Week: Their Own Private Idaho. One-bedroom, 250-square-foot cedar cabin on 160 acres. … At more than $5,000 an acre, the price is high compared to recent sales, but brokers say properties surrounded by federal land trade higher, and the land improvements contribute to the cost." (Wall Street Journal, June 30, 2000, page W10.)

Field Data Collection

We ran a pilot collection of the data in three counties and made several modifications to the data collected.

Because of the distance between towns and the relatively sparse population in the Upper Peninsula of Michigan population and employment, which are closely related, did not always reflect the relative importance of particular communities. Amenities in the community were more important that population. We deleted population and focused on community attributes.

Stumpage value would have required owner's permission to enter the property in many cases and, for larger properties with several forest types, would have taken several days to complete for an individual property. We simplified the process by assigning each property which had at least some marketable timber to one of five stumpage value categories. Each person involved in data collection had experience marking and valuing timber.

Few properties had substantial wetlands. The impact of some types of wetlands on a property was also captured in the stumpage value of the property. This category was dropped.

We felt that potential to subdivide was more important than any subdivision which may have previously occurred. This variable was changed to reflect the potential for future subdivision rather than the history of subdivision.

More categories were added to view types and road access to reflect the variability we saw in the pilot sample. Categorical data was collected as 0,1 dummy variables for each category within the variable.

The final set of independent variables are shown in Table 2.

Many of the variables represented by dummy variables required consistent categorization during field collection. Figures 2 through 19 show examples of dummy variable categories.

Table 2. Final set of independent Variables.

Variable	Units
Sale Price	dollars
Parcel Size	acres
Building Present	yes =1, no = 0
Assessed Value of Land	dollars
Assessed Value of Building	dollars
Lake Front	yes =1, no = 0
Lake Front length	feet
Lake Front Type	Five categories
Year of Sale	year
Beach Type	six categories
Stumpage Value	five categories
County	Dummy Variable for each county
Dock Present	yes =1, no = 0
Dock Possible	yes =1, no = 0
Road Access	five categories
Current Utilities	yes =1, no = 0
Potential Utilities	yes =1, no = 0
Other Lake on Property	yes =1, no = 0
Stream on Property	yes =1, no = 0
Public Land Adjacent	yes =1, no = 0
Length of Public Land Boundary	feet
Commercial Forest Land Adjacent	yes =1, no = 0
Commercial Forest Land Boundary	feet
Distance to Public Access	miles
Distance to Small Town	miles
Distance to Large Town	miles
View	six categories
Subdivision allowed	yes =0, no = 1

Figures 2 through 5 show examples of road access.

Figure 2. Category 1 road access. Two track, 4x4 seasonal access.

Figure 3. Category 2 road access, 4x4 or seasonal 2x4 access.

Figure 4. Category 4 road access. Unpaved, all weather road.

Figure 5. Category 5 road access. Paved, all weather road.

Figures 6 through 9 show the five categories of stumpage values. Properties of less than one acre were not assigned a stumpage value. We used some judgement for small properties to determine if harvesting was feasible, for example location of a building might restrict an owner's options and choices. None of the 162 non-shoreline properties had category 5 (very high) stumpage, value. Only nine properties had category 4 (high) stumpage value.

Figure 6. Category 1 (very low) stumpage value.

Figure 7. Category 2 (low) stumpage value.

Figure 8. Category 3 (moderate) stumpage value.

Figure 9. Category 4 (high) stumpage value.

Beach Front categories are shown in Figures 10 to 12 and are summarized in Table 3.

Table 3. Beach Front Types

Type	Description
0	Rock (Default)
1	Gravel / Rock
2	More gravel than sand
3	Roughly equal sand and gravel
4	More sand than gravel
5	Sand
6	Dense Vegetation

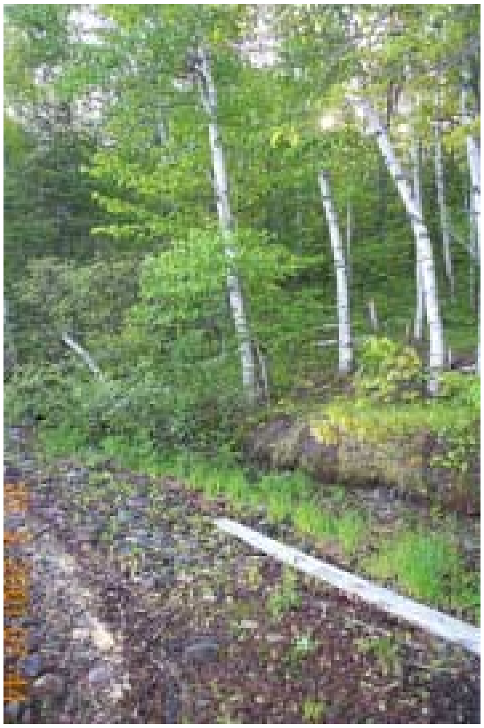

Figure 10. Category 1 beach, a rocky beach.

Figure 11. Category 5 beach, a sand beach.

Figure 12. Category 6 beach, dense vegetation.

Lakefront types are shown in Figures 13 to 15 and are summarized in Table 4.

Table 4. Lakefront Types

Type	Description
0	Large cliff (Default)
1	Small cliff or bluff
2	Short steep slope
3	Short gentle slope
4	Long gentle slope
5	Flat or Level Beach

Figure 13. Category 1 Lakefront, a small bluff or cliff.

Figure 14. Category 2 Lakefront, a short steep slope.

Figure 15. Category 5 Lakefront, a flat to nearly level lakefront.

Figures 16 through 19 show the different categories of views in the study and views are summarized in Table 5.

Table 5. View Types

Type	Description
0	Wooded view (Default)
1	Other lake
2	River
3	Mountain
4	Lake Superior
5	Lake Superior + other attribute
6	Open or Fields

Figure 16. Wooded view, the default of 0 in the view variable.

Figure 17. Category 4, a view of Lake Superior.

Figure 18. Category 5, a view of Lake Superior plus one other view property, in this case distant shore with low hills.

Figure 19. Category 6, a view of an open field.

Field Data Collection

Field data was collected in two broad categories, property data and urban/park data. Within any one county data was always collected by the same individual. A dummy variable for county was included in the data set.

Property Data

For each county we located all property transactions within three miles of Lake Superior which had been sold within the previous three years and made a photocopy of the deed.

Properties were located in the most recent County Plat Book (Table 6) and distance to Lake Superior was confirmed. From the Plat book we also determined whether the property was adjacent to public land or commercial forest act land. Our interviews with local real estate agents and information in real estate brochures indicate that land adjacent to either of these two types of land is more valuable than other real estate, all other attributes of the properties being equal.

The deed was checked for unusual liens or restrictions on the property. Properties with such restrictions were flagged in the data base. In addition, we determined if there were restrictions on subdivision of the properties.

We excluded properties greater than 80 acres or those where a transaction had occurred at prices obviously below market value. In the latter cases there was typically other evidence that the transaction had taken place outside of the typical real estate market. For example, transfers may have been from parents to a child or as part of an estate settlement. Several assessors also indicated when transactions did not occur at market value.

Table 6 – Date of Publication of County Plat Books

County	Date
Alger	1998
Baraga	1997
Chippewa	1997
Gogebic	2000
Houghton	2000
Keweenaw	2000
Luce	1998
Marquette	1998
Ontonagon	1996

Urban / Park Data

Data on urban areas was collected from the both the county plat books and direct observation of the communities. Towns size was based upon functional size of the town rather than population. We observed whether or not a town had a hospital, large grocery store, large department store, county government, a high school, or at least three service stations. If had all or all but one of these criteria it was considered a large town. If the community had two or more of these attributes it was considered a small town. The geographic location of the town was recorded using a global position system (GPS).

Each park was visited to determine its size, GPS location, and waterfront amenities. We noted whether the park could be used for day-use recreation such as picnicking, launching boats, or swimming. Other activities, especially camping, might be of value to people visiting for short periods, but would be of limited value to property owners. Some specialized activities, such as skiing in Porcupine Mountain State Park, are available to any class of landowners and the value of these types of activities should be similar for shoreline and non-shoreline property.

Data Analysis Methods

A master spreadsheet containing records of all 465 properties was developed and transformed in to SAS readable format. Of these, 215 records were complete. The usable properties were divided in to two sets, 162 properties which were not shoreline properties and an additional 53 properties were located on Lake Superior are used in this study. An Excel spreadsheet containing the data is available from the first author.

Several variables were transformed. Sale prices reflect the combined value of the land plus a building if one is present. To adjust prices to reflect on the land value the sale price was multiplied by the ratio of the assessed land value to the total assessed value. Because property sizes up to 80 acres were used we used the natural log of the adjusted land value per acre as the dependent variable. Distances from the property to the public access park and the towns were also transformed using the natural logarithm of the distance.

SAS for Windows (Version 8) was used to perform Generalized Linear Model tests (PROC GLM) to develop the hedonic regression models. Correlation tests (PROC CORR) following Steele and Torrie (1960) were performed to help derive the model in the case of shoreline properties and to observe the impact of multicollinearity in for both the shoreline and non-shoreline data sets.

For shoreline properties a full model was estimated and then using the results from the estimation and the correlation tests a reduced model was estimated. Since there were only 53 sample points for shoreline property we estimated a "full" model based upon statistically significant correlations in the correlation tests. The "full" shoreline model did include some dummy variables which were not significant but were related to significant variables. For example two beach types were correlated with the natural log of land value per acre. Four of the five beach type dummy variables were used in the "full" model. (One category of beach type was not included to prevent full rank estimation.) A reduced shoreline model was derived from the "full" shoreline model.

IV. Results and Discussion

Non-Shoreline Properties.

The original model estimated was:

$$LnLVpA = \alpha + \underset{\cdot\cdot}{\beta}\,(Sz, B, S1, S2, S3, S4, SV4, SV3, SV1, CA, CB, CC, CG, CH, CK, CL, CM, RA5, RA4, RA3, RA2, RA1, CU5, CU4, CU3, CU2, CU1, UA5, UA4, UA3, UA2, UA1, OL, OS, PL, PLf, CFR, CFRf, LnP, LnT1, LnT2, V6, V5, V4, V3, V2, V1, Div)$$

β is a vector of estimated parameters. Variables, their estimated parameters, and T values are shown in Table 7.

Table 7. Estimated Parameters for Non-Shoreline Full Model.

Descriptive Variable	Symbolic Variable	Estimated Parameter	Pr > |T|
Intercept		10.09	< 0.001
Parcel Size	Sz	-0.04	< 0.001
Building Present*	B	0.49	0.172
Year of Sale*			
(1998)	(S1)		
1999	S2	0.35	0.214
(2000)	(S3)		
2001	S4	0.23	0.239
County*			
Alger	CA	-0.61	0.202
Baraga	CB	0.28	0.468
Chippewa	CC	0.51	0.314
Gogebic	CG	1.28	0.323
Houghton	CH	-0.01	0.983
Keweenaw	CK	0.20	0.609
Luce	CL	-0.45	0.339
Marquette	CM	-0.45	0.926
(Ontonagon)	(CO)		
Stumpage Value*			
(very high)	(SV5)		
high	SV4	-0.45	0.323
moderate	SV3	-0.17	0.502
(low)	(SV2)		
very low	SV1	-0.50	0.042
Road Access*			
Paved	RA5	0.37	0.209
(Unpaved, all weather)	(RA4)		
Unpaved	RA3	0.01	0.971
4x4, Seasonal 2x4	RA2	-0.02	0.995
Seasonal 4x4	RA1	0.84	0.073
Current Utilities*			
Electric, phone, water and natural gas	CU5	0.16	0.725
(Electric, phone, water and propane)	(CU4)		
Electric, phone and water	CU3	0.27	0.607
Electric, phone or water	CU2	0.59	0.344
Electric only	CU1	-1.14	0.107

TABLE 7 CONTINUED ON NEXT PAGE.

Notes:
(1) Variables in parentheses were not estimated in order to avoid full rank estimation or because no properties had that attribute.
(2) Categories with dummy variables marked with an “*”.

Table 7 (Continued). Estimated Parameters for Non-Shoreline Full Model.

Descriptive Variable	Symbolic Variable	Estimated Parameter	Pr > |T|
Potential Utilities*			
Excellent	UA5	-0.31	0.340
(Very good)	(UA4)		
Good	UA3	-0.11	0.699
Fair	UA2	0.08	0.827
Poor	UA1	0.38	0.401
Other Lake on Property*	OL	-1.78	0.207
Stream on Property*	OS	0.03	0.929
Length of Public Land Boundary	PLf	0.01	0.1957
Commercial Forest Land Boundary	CFRf	-0.01	0.577
Distance to Public Access	LnP	-0.36	0.014
Distance to Small Town	LnT1	-0.11	0.364
Distance to Large Town	LnT2	-0.64	0.026
View*			
Open	V6	-0.78	0.177
Lake Superior plus attribute	V5	1.31	0.240
(Lake Superior)	(V4)		
Mountain	V3	1.27	0.482
River or Stream	V2	0.81	0.081
Other Lake	V1	-1.67	0.012
Subdivision allowed*	Div	-0.12	0.567

Notes:
(1) Variables in parentheses were not estimated in order to avoid full rank estimation or because no properties had that attribute.
(2) Categories with dummy variables marked with an "*".

The estimated equation had an F value of 5.70 with 40 degrees of freedom and was significant at 0.0001 level. The r^2 is 0.65. The significant variables are parcel size, very low stumpage value, poor road access, poor (electric only) current utilities, distance to the park, distance to large town, and views of rivers, streams, or lakes other than Lake Superior. The signs of the significant variables are what one would expect except for poor road access, poor utilities associated with the property and a view of another lake. We then developed a more tractable reduced model, one with fewer explanatory variables. We also discuss the results in light of collinearity among the variables and the coefficient correlations.

A Reduced Model.

The original estimation and correlation table for all variables suggested several ways that the model could be simplified by eliminating variables which were not statistically significant in the initial model. There is the danger that selecting a limited set of variables can bias the results or lead to selective reporting of the results (Granger and Newbold, 1974; Leamer, 1983). We will also discuss the stability of our results. The reduced model is shown in Table 8.

Table 8. Estimated Parameters for the Non-Shoreline Reduced Model.

Descriptive Variable	Symbolic Variable	Estimated Parameter	Pr > |T|
Intercept		9.95	< 0.001
Parcel Size	Sz	-0.04	< 0.001
County*			
Chippewa	CC	0.87	0.007
Stumpage Value*			
(very high)	(SV5)		
high	SV4	-0.11	0.753
(moderate)	(SV3)		
low	SV2	-0.06	0.753
very low	SV1	-0.44	0.055
Road Access*			
Paved	RA5	0.27	0.211
Unpaved, all weather	RA4	0.01	0.963
(Unpaved)	(RA3)		
(4x4, Seasonal 2x4)	(RA2)		
Seasonal 4x4	RA1	0.63	0.079
Distance to Public Access	LnP	-0.37	0.002
Distance to Small Town	LnT1	-0.21	0.047
Distance to Large Town	LnT2	-0.46	0.002
View*			
Open	V6	-0.758	0.287
Lake Superior plus attribute	V5	0.01	0.980
Lake Superior	V4	0.34	0.472
Mountain	V3	-0.72	0.482
River or Stream	V2	0.80	0.061
Other Lake	V1	-1.69	0.006

Notes:
(1) Variables in parentheses were not estimated in order to avoid full rank estimation or because no properties had that attribute.
(2) Categories with dummy variables marked with an "*".

The estimated equation had an F value of 12.32 with 17 degrees of freedom and was significant at 0.0001 level. The r^2 is 0.60. The significant variables are parcel size, location in Chippewa County, very low stumpage value, poor road access, distance to the park, distance to large and small towns, and views of rivers, streams, or lakes other than Lake Superior. The signs of the significant variables are what one would expect except for poor road access and a view of another lake.

Some variables were closely correlated, indicating the multicollinearity existed in our complete, initial model. All utility variables were closely correlated with road access variables and essentially explained the same property attributes. This is reasonable since most utility lines follow roads and even propane service requires a road for service.

Building and parcel size were closely correlated. Small parcels were more likely to have a building. If the parcel size variable is removed from the reduced model and replaced with the dummy variable representing the presence of a building, the building variable was significant. This may indicate that assessors over assess the value of land and underassess the value of buildings on properties where buildings are present. However, collinearity with other variables leaves this conclusion open to question. We did find some properties had an unreasonable price per acre, with one case where land value was over $100,000 per acre. All cases with high land values per acre also had a building on the property. Though speculative, this is further evidence that buildings are sometimes under-assessed while land is over-assessed.

As an aside, there is some debate as to whether one should use assessed values or transaction values for prices. Our data set showed considerable under-assessment for some properties, even when adjusting assessment price to market price based upon assessment. Transactions, at least in our data set, were a more reliable indicator of true price.

We used several reduced model specifications to reduce multicollinearity. In all models parcel size, the natural logarithm of the distance to the park (public access to Lake Superior), the view of the other lake, the natural logarithm of the distance to the large town, poor road access and very low stumpage value remained significant. The signs on the estimated parameters did not change and the values of the estimated parameters remained similar to those reported.

The r^2 of 0.65 in the complete model and of 0.60 in the reduced model compares well with similar studies, especially given the three year span of data used in the study and the wide range in property times. Geoghegan *et al*. (1997) reported an r^2 of just under 0.50 and Barnett (1985) reported an r^2 of 0.66 for his linear model and r^2 of 0.76 when using a logarithmic transformation of his independent variable. Leefers and Jones (1996) reported an r^2 of 0.56 for a similar study of rural properties in Michigan. We believe the reported r2 is quite good considering the small sample size and when compared to other studies. This is probably due to the use of primary rather than secondary data.

Shoreline Property

Since there were only 53 sample shoreline properties and there are 64 independent variables, a full model could not be estimated. Instead, a correlation table for all 64 independent variables plus the natural log of land value per acre (the dependent variable) was calculated. Table 9 shows those variables which were correlated (with a significance level of 0.10) with the natural log of land value per acre. While not statistically significant, the Pearson Correlation Coefficient for the natural log of the distance to the nearest public access is also included in Table 9.

The signs of the correlation coefficients are logically consistent except for the sign for lakefront length. One would expect that as lakefront length increases so would the property value per acre. However, the sample size is small and the number of other variables which drive parcel price is large. The regression results using the same data help explain this apparent inconsistency.

It is important to note distance to public access is no longer significantly correlated with the price of the parcel. Because individuals now have direct private access, public access does not significantly influence price, whereas for non-shoreline property the ability to access Lake Superior through public property did influence the price of the property.

We used the correlation results to develop the reduced regression model:

$$LnLVpA = \alpha + \beta(Sz, LFL, BT6, BT5, BT1, CA, CB, CC, CH, CK, CL, LnP, LnT1,).$$

Table 9. Independent variables correlated with the natural log of land value per acre at a 0.10 level of statistical significance for shoreline properties.

Variable	Symbol	Pearson Correlation Coefficient	Prob > |r|
Size	Sz	-0.563	<0.0001
Lakefront Length	LFL	-0.351	0.0099
Lakefront Type 2	LFT2	0.257	0.0635
Sale Year 1998	S4	0.2450	0.0103
Very Low Stumpage Value	SV1	-0.272	0.0487
Low Stumpage Value	SV2	-0.380	0.0050
Beach Type 5	BT5	-0.346	0.0111
Beach Type 1	BT1	0.269	0.0512
Chippewa County	CC	0.400	0.0031
Keweenaw County	CK	0.271	0.0494
Ontonagon County	CO	-0.346	0.0113
Poor Road Access	RA1	-0.285	0.0388
Fair Utility Access	UA2	-0.242	0.0807
Length of Public Frontage	PL	-0.338	0.0136
Natural Log of Distance to Nearest Public Lake Access	LnP	-0.191	0.1705
Natural Log of Distance to Nearest Small Town	LnT1	-0.497	0.0002
Natural Log of Distance to Nearest Large Town	LnT2	-0.450	0.0007
Open View	V6	0.344	0.0116
View of River	V2	-0.310	0.0238
View of other Lake	V1	0.230	0.0976

β is a vector of estimated parameters. Variables, their estimated parameters, and T values are shown in Table 10. The estimated equation has an F value of 7.37 which is statistically significant at the <0.0001 level. The r^2 is 0.71.

Table 10. Estimated parameters for reduced model using shoreline property data set.

Descriptive Variable	Symbolic Variable	Estimated Parameter	Pr > |T|
Intercept		10.358	< 0.001
Parcel Size	Sz	-0.128	< 0.001
Lakefront Length	LFL	0.002	0.018
Beach Type*			
Dense Vegetation	BT6	-1.096	0.156
Sand	BT5	-0.578	0.046
Rock / Gravel	BT1	0.053	0.902
County*			
Alger	CA	-0.005	0.999
Baraga	CB	-0.581	0.562
Chippewa	CC	0.984	0.009
Houghton	CH	1.280	0.016
Keweenaw	CK	1.212	0.014
Luce	CL	0.874	0.019
Distance to Public Access	LnP	0.058	0.533
Distance to Small Town	LnT1	-0.422	0.010

Note: Categories with dummy variables marked with an “*”.

Lakefront length in the regression model is significant and has the expected sign. The impact is small because the dependent variable is not the total value of the property, but the natural log of the land value per acre. Lakefront types are not as important as beach types and there are strong correlations between certain lakefront types and beach types. There was little variability in road access. Most properties had good road access, which also implies good utilities and good utility access. There was little variability in these independent variables. Chippewa, Houghton, and Keweenaw Counties had more valuable lakefront properties when other independent variables are included in the model. Ontonagon County (omitted to prevent full rank estimation) had lower property values.

Distance to public access to Lake Superior did not influence the price per acre of shoreline properties. This is expected since these properties already provide access. Any additional benefits from boat launches at public access points apparently did not have an impact on price.

As with the non-shoreline model we estimated several reduced regression models but report only this model. Choice of counties will influence the estimated parameters and T values for individual counties, but this model provides a fair representation of the results. The dummy variables for Chippewa Houghton, and Keweenaw Counties generally increase the dependent variable relative to other counties while Ontonagon reduces the dependent variable relative to other counties. Distance to a large town and a small town were highly correlated. Either could be included in a reduced regression model as a significant independent variable.

V. Conclusions

Our data and the analysis of the data suggests, at reasonable levels of statistical significance, that public access to Lake Superior does increase the value of nearby non-shoreline property. We also found that distance to public access probably does not increase the value of shoreline properties. Given the results from other studies, these are expected results, though it is important to realize that most studies using hedonic analysis or property values are done in urban or suburban areas.

For both shoreline and non-shoreline properties increasing size of the property reduced the price per acre. Proximity to towns increased the value of the properties. County location was important in both data sets. All properties in Chippewa County were more valuable. For shoreline properties, those in Houghton and Keweenaw were also relatively more valuable while those in Ontonagon County were relatively less valuable. One can speculate that Ontonagon is a temporary supply-driven phenomenum. Recent mining and manufacturing decline in the county and associated population declines may be placing more property on the market in Ontonagon County.

View, stumpage value and road access were statistically significant categories for non-shoreline property while beach type and lakefront length were important for shoreline properties. The data set for shoreline properties did not include a wide range of values for stumpage value or road access. View would be less important Lake Superior shoreline properties since they have a *de facto* view of the Lake.

Policy Implications.

A wide range of policy methods exist to direct development, from zoning to land development charges (Watkins, 1999). Our study indicates that public lake access will increase the value of nearby properties. This can be used to develop additional land use planning tools and methods that can protect shorelines from development. Clustered private development away from a lake with private, but undeveloped collective private ownership of lakeshore can retain ecological values and allow development, especially of second homes, without sacrificing overall returns from real estate development. Such arrangements are already in place along parts of the New England coastline. A similar model of private development with preserved green space has been developed in the Santa Lucia Preserve, California (Carlton, 2001). Housing is concentrated in one area and preserve, managed by a neutral and independent conservancy for wildland preservation, in the majority of the area. Properly structured conservation easements could also be used to implement the preservation of shoreline, either with or without associated public access (Boyd *et al*., 1999).

While our paper shows that second home development on property without water access benefits from public ownership of water access there are clearly more widely known and accepted benefits from public ownership. Cordell and Bergstrom (1989) found that almost all types of public land recreation will increase through 2040. If quality and cost of providing this recreation is to be maintained more public recreation areas are necessary.

Additional public acquisition of shoreline can be justified not only on the basis of public recreational use and ecological values but from the economic benefits that accrue to nonlakeshore property. The real transaction and, therefore, assessed values of property should increase with increased public access.

There are several caveats for readers of this report. We have made no effort to distinguish different demographic groups which may purchase property. Some studies have distinguished between primary and secondary homes (Leefers and Jones, 1996) while Deller (1995) looked at the impact of retirees on a region. While this study has implicitly included this type of information by our choice of independent variables, we cannot model the impact of different levels of changes within these demographic groups.

In addition, public amenities and recreational opportunities are economic development tools, especially for mobile, technology-intensive firms (Gottlieb, 1994). Gottlieb warns that amenities such as schools, reduced crime, limited traffic and recreational and aesthetic amenities are not least-cost methods of economic development. Improvements in any area typically require public expenditures and governments should balance the cost of these services against the benefits which they provide.

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